# Nutrient Content of Squawroot, *Conopholis americana*, and Its Importance to Southern Appalachian Black Bears, *Ursus americanus* (Carnivora: Ursidae)

STEVEN G. SEIBERT[1] AND MICHAEL R. PELTON
*Department of Forestry, Wildlife and Fisheries, The University of Tennessee, Knoxville, Tennessee 37901*

*ABSTRACT*—Squawroot (*Conopholis americana*), a preferred late spring and early summer food of black bears (*Ursus americanus*), was collected from Pisgah National Forest, North Carolina, on a weekly basis from 25 April to 4 July 1987. Proximate analysis procedures were used to determine the nutrient content of the plant. Samples were examined for nutrient differences between the capsule and stems. Peak percentages were 13% crude protein (capsule), 31% crude fiber (capsule), 3% fat [either extract] (capsule), and 77% nitrogen-free extract [NFE] (whole plant). Gross energy averaged 4.84 kcal/dry g. Levels of crude protein, crude fiber, and either extract were similar to values reported for soft mast species eaten by bears, and NFE was greater than herbaceous material consumed in spring. Trends in protein and fat content were higher in the capsules; protein decreased as crude fiber increased. Nitrogen-free extract levels were relatively high throughout the study and likely represent an important energy source for bears feeding on squawroot.

Squawroot (*Conopholis americana*) is a perennial, parasitic plant (Musselman 1982) common to the Piedmont and southern Appalachian (Harvill et al. 1981). Little is known about the plant, but it appears to grow only from the roots of oak trees (Musselman and Mann 1978), probably by infecting young root tips (Musselman 1982).

Squawroot also is a common food eaten by black bears in spring and early summer in the southern Appalachians (Beeman and Pelton 1980, Eagle and Pelton 1983, Garner 1986); the species is locally abundant and may be nutritionally important to bears. Because of its local abundance and time of maturity (often the first productive food available), squawroot patches may influence movements of female bears in the southern Appalachians. By locating readily-available, high-energy foods, females may improve their energy benefit/cost ratio, thereby increasing cub survival. The purpose of this study was to determine the nutritional content of squawroot.

[1] Present address: United States Fish and Wildlife Service, 6620 Southpoint Drive South, Suite 310, Jacksonville, Florida 32216.

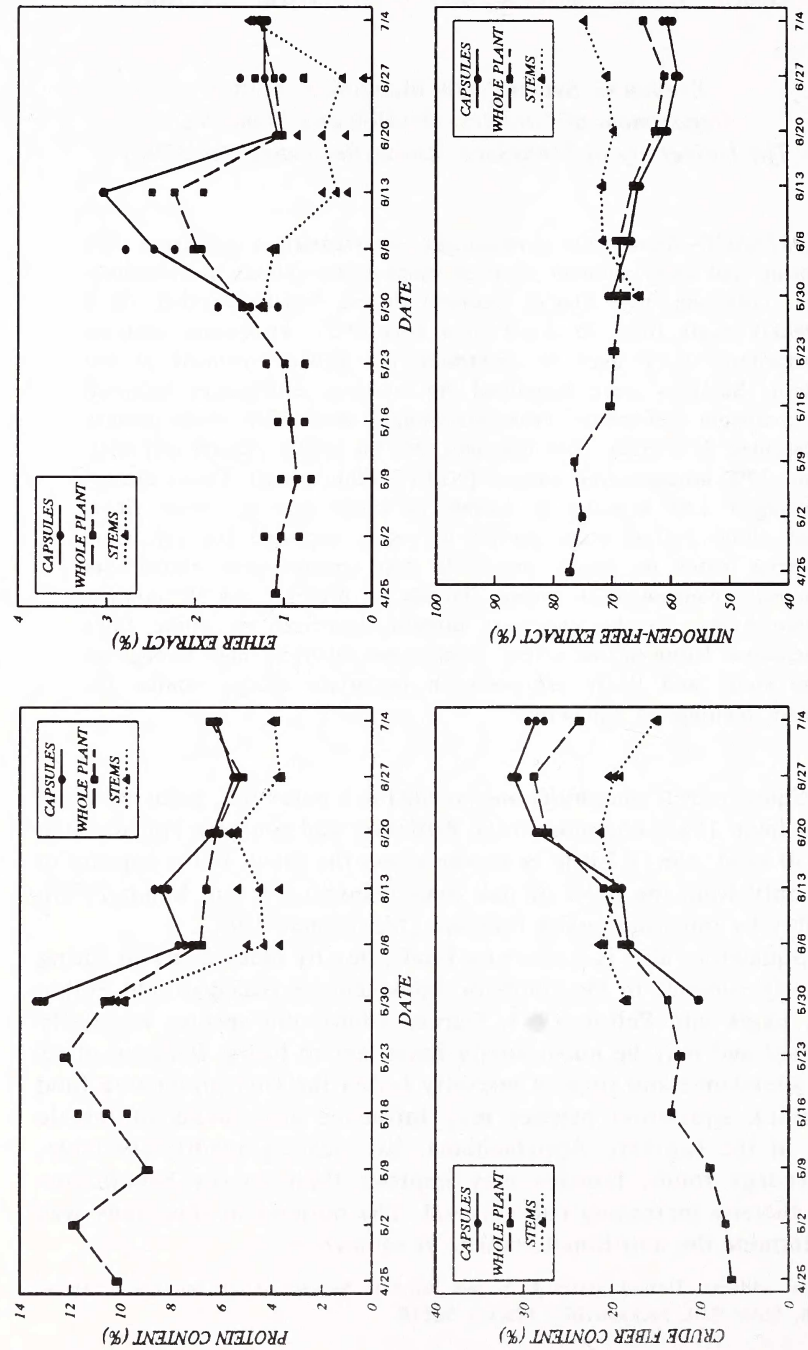


Fig. 1. Nutrient content of squawroot collected weekly on Pisgah National Forest, North Carolina, 1987.

## STUDY AREA

The study was conducted on the Harmon Den Bear Sanctuary, Pisgah National Forest, North Carolina. The area is part of the Blue Ridge Physiographic Province (Fenneman 1938). The mountains are sharply dissected and the terrain is steep. Elevations range from 439 to 1,411 m; slopes average over 30% (Finlayson 1957). The area is described as a warm-temperate rain forest (Thornwaite 1948). Vegetation is diverse and changes dramatically with aspect, elevation, soil, and drainage. The general area is among the most botanically diverse temperate areas in the world (Whittaker 1956).

The majority (89%) of Harmon Den is in hardwood cover types, consisting of white oak (*Quercus alba*)-northern red oak (*Q. rubra*)-hickory (*Carya* sp.) (45%), yellow poplar (*Liriodendron tulipifera*)-white oak-northern red oak (26%), yellow poplar (10%), scarlet oak (*Q. coccinea*) (5%), and chestnut oak (*Q. prinus*) (3%) (U.S. Forest Service 1988).

## METHODS

Whole plants of squawroot (20–30 plants) were collected weekly from 25 April to 4 July 1987 at elevations ranging from 946 to 1,068 m. Quantities of 639 to 1,123 g were obtained each week; samples were composited, therefore no statistical analysis could be performed. Thus, the trends or differences noted in this paper may not be statistically significant. Oven-dried samples were analyzed for crude protein, crude fiber, nitrogen-free extract, fat (ether extract), and gross energy (Maynard et al. 1979).

Capsules and stems were analyzed separately to detect nutritional differences between them because, as squawroot matured, bears were observed to selectively feed on the capsule portion of the plant. Capsules were difficult to separate from the stem before 30 May.

## RESULTS

### Crude Protein

The trend for crude protein ($\bar{x}$ = 8.8%, SE = 0.51, range = 5.1-12.3%) of the entire plant peaked during late May (Fig. 1). Capsules ($\bar{x}$ = 7.8%, SE = 0.78, range = 5.5–13.4% contained more protein than stems ($\bar{x}$ = 5.5%, SE = 0.58, range = 3.6–10.2) throughout the study. The highest percentage of protein occurred in the capsules collected 30 May. However, much of this protein may have been in the seeds (Wainio and Forbes 1941) and unavailable because bears do not crack or digest the seed coat (Eagle and Pelton 1983).

### Fat (Ether Extract)

Fat content in squawroot was low (Fig. 1) and similar to soft mast species such as huckleberry (*Gaylussacia* sp.) and black gum (*Nyssa sylvatica*) (Landers et al. 1979), which also are important to bears. The greatest trend in percentage of fat occurred in the capsules collected on 13 June. Fat trends were higher in capsules ($\bar{x}$ = 1.53%, SE = 0.14, range = 1.0–3.0%) than stems ($\bar{x}$ = 0.75%, SE = 0.12, range = 0.1–1.4%) for all except the final collection. Mean fat content for the whole plant was 1.34% (SE = 0.69, range = 0.7–2.5%).

### Crude Fiber

The trend in crude fiber for the stem ($\bar{x}$ = 19.23%, SE = 0.65, range = 14.8–21.5%) was similar throughout the study (Fig. 1); this might be expected because the stem is the only structural component of the plant. Crude fiber increased in the capsules ($\bar{x}$ = 22.62%, SE = 2.24, range = 10.2–31.5%) throughout the study period and appeared negatively correlated with protein. Crude fiber averaged 16.53% (SE = 1.65, range = 6.4–29.0%) for the whole plant.

### Nitrogen-Free Extract (NFE)

Nitrogen-free extract was highest in early spring and lowest in late June in the whole plant ($\bar{x}$ = 69.1%, SE = 1.14, range = 61.1–77.4%) and capsules ($\bar{x}$ = 63.7%, SE = 1.23, range = 58.4–70.7%) (Fig. 1). NFE increased from late May to July in the stems ($\bar{x}$ = 70.7%, SE = 2.88, range = 65.1–74.9%).

### Gross Energy

There was little variation in gross energy among weeks, or between the different plant parts; this agrees with Robbins (1983) and Powell and Seaman (1990). Gross energy averaged 4.8 kcal/dry g (SE = 0.03, range = 4.7–5.1) (whole plant); 5.0 kcal/dry g (SE = 0.05, range = 4.9–5.2) (capsules); and 4.7 kcal/dry g (SE = 0.06, range = 4.3–5.0) (stems).

The nutritional content of squawroot appeared to change over time. Protein and nitrogen-free extract (NFE) concentrations were greatest during the early weeks. Fat was greatest during middle of the study, and crude fiber was lowest early and increased with time.

## DISCUSSION

Spring diets of bears in the southern Appalachians contain large amounts of herbaceous material (Beeman and Pelton 1980, Eagle and Pelton 1983, Garner 1986). Herbaceous material is relatively high in protein (Landers et al. 1979, Eagle and Pelton 1983). Nitrogen-free

extract, however, is lowest in spring foods (Landers et al. 1979). Eagle and Pelton (1983) suggested that squawroot was probably an important energy source for bears because the carbohydrates in squawroot are readily absorbed.

Squawroot is likely a major source of carbohydrates (represented by relatively high NFE concentrations) in the spring diet of bears in the Harmon Den area. Nitrogen-free extract concentrations in squawroot tended to remain relatively high throughout the study, and carbohydrates available in squawroot appear to be easily absorbed (Eagle and Pelton 1983); this may be important to a bear's overall spring and early summer condition. The combination of high protein herbaceous material and relatively rich carbohydrate squawroot may be important for bears recovering from the denning period; particularly for lactating females with cubs, because of their increased nutritional requirements (Eagle and Pelton 1983, Rogers 1987).

The habitat types where squawroot occurs (i.e., mature oak stands) should receive special concerns, as management of these stands for peak acorn production also would maintain ample sources of squawroot for bears throughout their range in the southern Appalachians.

## LITERATURE CITED

Beeman, L. E., and M. R. Pelton. 1980. Seasonal foods and feeding ecology of black bears in the Smoky Mountains. Proceedings of the International Conference for Bear Research and Management 4:141–147.

Eagle, T. C., and M. R. Pelton. 1983. Seasonal nutrition of black bears in the Great Smoky Mountains National Park. Proceedings of the International Conference for Bear Research and Management 5:94–101.

Fenneman, N. M. 1938. Physiography of the eastern United States. McGraw-Hill Book Company, New York, New York.

Finlayson, C. P. 1957. The geology of the Max Patch Mountain area, Lemon Gap Quadrangle, Tennessee-North Carolina. M.S. Thesis. The University of Tennessee, Knoxville.

Garner, N. P. 1986. Seasonal movements, habitat selection, and food habits of black bears (*Ursus americanus*) in Shenandoah National Park. M.S. Thesis. Virginia Polytechnic Institute and State University, Blacksburg.

Harvill, A. M., Jr., T. R. Bradley, and C. E. Sterns. 1981. Atlas of the Virginia flora. Part II Dicotyledons. Virginia Botanical Associates, Farmville, Virginia.

Landers, J. L., R. J. Hamilton, A. S. Johnson, and R. L. Marchinton. 1979. Foods and habitat of black bears in southeastern North Carolina. The Journal of Wildlife Management 43:143–153.

Maynard, L. A., J. K. Loosli, H. F. Hintz, and R. G. Warner. 1979. Animal nutrition. Seventh edition. McGraw-Hill Book Company, New York, New York.

Musselman, L. J. 1982. The Orobanchaceae of Virginia. Castanea 47:266–275.

Musselman, L. J., and W. F. Mann, Jr. 1978. Root parasites of southern forests. United States Department of Agriculture, Forest Service General Technical Report SO-20.

Powell, R. A., and D. E. Seaman. 1990. Production of important black bear foods in the southern Appalachians. Proceedings of the International Conference for Bear Research and Management 8:183–187.

Robbins, C. T. 1983. Wildlife nutrition and feeding. Academic Press, Incorporated, New York, New York.

Rogers, L. L. 1987. Effects of food supply and kinship on social behavior, movements, and population growth of black bears in northeastern Minnesota. Wildlife Monograph 97:1–72.

Thornwaite, C. W. 1948. An approach toward a rational classification of climate. Geogography Review 38:55–94.

Wainio, W. W., and E. B. Forbes. 1941. The chemical composition of forest fruits and nuts from Pennsylvania. Journal of Agricultural Research 62:627–635.

Whittaker, R. H. 1956. Vegetation of the Great Smoky Mountains. Ecological Monograph 26:1–50.

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